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Invention: FUEL PUMP

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This is a:

☐ Provisional Application

☐ Regular Utility Application

☒ Continuing Application

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☐ PCT National Phase Application

☐ Design Application

☐ Reissue Application

☐ Plant Application

☐ Substitute Specification
Sub. Spec Filed ____________
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Sub. Spec. filed ____________
In App. No ____/______

SPECIFICATION

FUEL PUMP

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Patent Application Serial No. 10/211,556, which was filed on August 5, 2002, which is a continuation of U.S. Patent Application Serial No. 09/344,029, now abandoned, which was filed on June 25, 1999. The contents of both applications are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] This invention relates generally to fuel pumps, and more specifically, to fuel pumps for marine engines.

[0003] Internal combustion engines typically include a fuel pump for pumping fuel from a fuel tank to combustion chambers of the engine cylinders. In some known outboard engines including two cylinder banks, e.g., a V-6 type outboard engine, two fuel pumps may be required to pump fuel to each cylinder bank. Specifically, a first fuel pump delivers fuel to a first cylinder bank, and a second fuel pump delivers fuel to a second cylinder bank. Separate fuel pumps are required for each cylinder bank because such known fuel pumps only deliver fuel sufficient for one cylinder bank.

[0004] In addition, and to ensure efficient operation of an internal combustion engine, liquid fuel with no vapor bubbles should be delivered to the engine combustion chambers. Vapor can be created if the liquid fuel is allowed to expand within, or at the outlet of, the fuel pump. Vapor bubbles can form in the fuel at the inlet of the pump due to the fuel being drawn from the tank.

[0005] Also, at least some known fuel pumps includes small passages through which the fuel must flow. Such passages, however, can be clogged by dirt particles or other particles that may be carried by the fuel. As a result, an insufficient amount of fuel, or possibly even no fuel, may flow through the pump to the engine combustion chambers.

[0006] Further, some known fuel pumps are bulky and expensive to fabricate. With outboard engines, space within the engine is limited. These known fuel pumps therefore not only acid costs to the engine, but also occupy space that could be used for other components.

BRIEF SUMMARY OF THE INVENTION

[0007] The present invention, in one aspect, is a fuel pump having increased pump inlet suction and outlet pressures as compared to known fuel pumps. Such pressure increases

enable use of one fuel pump even with an engine including multiple cylinder banks, and facilitates elimination of vapor and air bubbles in the fuel. The fuel pump also does not include small, or narrow passages that are prone to be clogged by dirt or the like.

[0008] More specifically, and in one embodiment, the fuel pump includes a pump housing including an inlet and an outlet. An inlet nozzle extends from the inlet, and an outlet nozzle extends from the outlet. The inlet nozzle is configured to be coupled to a fuel line extending from a fuel tank, and the outlet nozzle is configured to be coupled to a fuel line extending to the engine block. The pump further includes first and second pump inlet covers. Each cover includes an air nozzle. The air nozzles are configured to be coupled to air lines extending from select cylinders of the engine as described below in more detail. The covers and the housing form first and second pumping chambers.

[0009] The pump also includes a first check valve located within the inlet nozzle and a second check valve located within the outlet nozzle. A first diaphragm and a first spring are located in the first pumping chamber, and a second diaphragm and a second spring are located in the second pumping chamber. The first pumping chamber is in flow communication with a passage through the inlet nozzle, and the second pumping chamber is in flow communication with a passage through the outlet nozzle. The first pumping chamber is inflow communication with the second pumping chamber via a check valve.

[0010] Prior to operation, air lines are coupled to the air nozzles. Typically, the air lines extend from engine cylinders that operate 180 degrees out-of-phase so that alternating pressure and vacuum forces are applied to the respective diaphragms. In addition, a fuel line from a fuel tank is coupled to fuel inlet nozzle, and a fuel line to the cylinders is coupled to fuel outlet nozzle.

[0011] In operation, the engine cylinders generate positive and negative pressure pulses. For example, and in an engine with an even number of cylinders, when one cylinder is on an upstroke, there is at least one cylinder on a downstroke at the same time. Therefore, one cylinder pulse is positive and one cylinder pulse in negative. When the negative and positive pulses are exerted on opposite sides of a diaphragm, the pulses are additive. In the above described fuel pump, when a positive pulse is present at one nozzle, a negative pulse is present at the other nozzle. Generally, fuel passes through the valve between and from the first pumping chamber to second pumping chamber. When the pulses are reversed, fuel is forced through the outlet passage and drawn into the inlet passage.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Figure 1 is a perspective view of a fuel pump in accordance with one embodiment of the present invention.

[0013] Figure 2 is an exploded view of the pump shown in Figure 1.

[0014] Figure 3 is a cross-sectional view through the pump along line 3 - 3 shown in Figure 1.

[0015] Figure 4 is a side view of the pump housing.

[0016] Figure 5 is a top view of the pump housing shown in Figure 4.

[0017] Figure 6 is a bottom view of the pump housing shown in Figure 4.

[0018] Figure 7 is an end view of a first end of the pump housing shown in Figure 4.

[0019] Figure 8 is am end view of a second end of the pump housing shown in Figure 4.

[0020] Figure 9 is a side view of a pump inlet cover.

[0021] Figure 10 is a top view of the pump inlet cover shown in Figure 9.

[0022] Figure 11 is a bottom view of the pump inlet cover shown in Figure 9.

[0023] Figure 12 is an end view of a first end of the pump inlet cover shown in Figure 9.

[0024] Figure 13 is an end view of a second end of the pump inlet cover shown in Figure 9.

[0025] Figure 14 is a side view of a pump port.

[0026] Figure 15 is an end view of a first end of the pump port.

[0027] Figure 16 is an end view of a second end of the pump port.

[0028] Figure 17 is a top view of a pump in accordance with a second embodiment of the present invention.

[0029] Figure 18 is a cross sectional view of the pump along line 18 - 18 shown in Figure 17.

DETAILED DESCRIPTION OF THE INVENTION

[0030] Figure 1 is a perspective view of a fuel pump 100 in accordance with one embodiment of the present invention. Fuel pump 100 includes a pump housing 102 including an inlet 104 and an outlet 106. An inlet nozzle 108 extends from inlet 104, and an outlet nozzle 110 extends from outlet 106. Inlet nozzle 108 is configured to be coupled to a fuel line extending from a fuel tank, and outlet nozzle 110 is configured to be coupled to a fuel line extending to the engine block. Pump 100 further includes first and second pump inlet covers 112 and 114. Each cover 112 and 114 includes an :air nozzle 116 and 118. Air nozzles 116 and 118 are configured to be coupled to air lines extending from select cylinders of the engine as

described below in more detail. Housing 102 also includes flanges 120 having respective openings 122 therethrough to facilitate securing pump 100 to an engine.

[0031] Figure 2 is an exploded view of pump 100 shown in Figure 1. As shown in Figure 2, pump 100 includes a first check valve 124 configured to be located within inlet nozzle 108 and a second check valve 126 configured to be located within outlet nozzle 110. When assembled to housing 102, first check valve 124 is located in inlet 104, and second check valve 126 is located in outlet 106. Pump 100 also includes a first diaphragm 128 and a first spring 130 configured to be located in a first pumping chamber 1 32, and a second diaphragm 134 and a second spring 136 configured to be located in a second pumping chamber 138. Covers 112 and 114 include seats 139 and 140 for diaphragms 128 and 134, respectively, and diaphragm 128 includes a seat 142 for spring 130. Cover 114 includes a seat 144 (not visible in Figure 2) for spring 136. When covers 112 and 114 are secured (e.g., sonic welded) to housing 102, covers 112 and 114 partially compress springs 130 and 136.

[0032] Figure 3 is a cross-sectional view through pump 100 along line 3 - 3 shown in Figure 1. Pump 100 includes first pumping chamber 132 and second pumping chamber 13 8. First pumping chamber 132 is in flow communication with a passage 146 through inlet nozzle 108 and inlet 104. Diaphragm 128 is located in first pumping chamber 132, and diaphragm 128 also is in flow communication with an air passage 148 through air nozzle 116. A support plate 150 is located between spring 130 and diaphragm 128.

[0033] Second pumping chamber 138 is inflow communication with a passage 152 through outlet nozzle 110 and outlet 106. Diaphragm 134 is located in second pumping chamber 138, and diaphragm 134 also is in flow communication with an air passage 154 through air nozzle 118. A support plate 156 is located between spring 136 and diaphragm 134. First pumping chamber 132 is in flow communication with second pumping chamber 138 via a check valve 158. Specifically, valve 158 is intermediate chamber 132 and chamber 138.

[0034] Check valves 124, 126, and 158 are well known. Generally, check valves 124, 126, and 158 each include a housing, a biasing spring, and a movable valve member having a sealing o-ring at one end. The movable valve member is normally biased to a closed position. Under the selected pressure conditions, the movable valve member moves from the closed position to an open position. Springs 130 and 136 and diaphragms 128 and 134 also are well known. The particular valves and springs selected depend, for example, upon the desired operation characteristics of pump 100. In pump 100, spring 130 is selected to be larger than spring 136 to provide the desired pump operation, as described below in more detail. Housing

102, covers 112 and 114, and nozzles 108 and 110 are molded using a plastic such as acetyl. Pump 100 also includes a plurality of o-rings 160, 162, 164, and 166 for preventing leakage.

[0035] Prior to operation, air lines are coupled to nozzles 116 and 118. Typically, the air lines extend from engine cylinders that operate 180 degrees out-of-phase so that alternating pressure and vacuum forces are applied to diaphragms 128 and 134. Rather than cylinders operating 180 degrees out-of-phase, it is possible to select cylinders having a different out-of-phase relationship, e.g., 120 degrees out-of-phase. In addition, a fuel line from a fuel tank is coupled to nozzle 108, and a fuel line to the cylinders is coupled to nozzle 110.

[0036] In operation, the engine cylinders generate positive and negative pressure pulses. For example, and in an engine with an even number of cylinders, when one cylinder is on an upstroke, there is at least one cylinder on a downstroke at the same time. Therefore, one cylinder pulse is positive and one cylinder pulse in negative. When the negative and positive pulses are exerted on opposite sides of a diaphragm, the pulses are additive. In fuel pump 100, when a positive pulse is present at nozzle 116 and a negative pulse is present at nozzle 118, fuel passes through valve 158 from first pumping chamber 132 to second pumping chamber 138. When the pulses are reversed, then a negative pulse is present at nozzle 116 and a positive pulse is present at nozzle 118. As a result, fuel is forced through outlet passage 152 and drawn into inlet passage 146.

[0037] In comparison to at least some known fuel pumps, and through use of the pump configuration and operation as described above, the pump inlet suction and outlet pressures are significantly increased. Such pressure increases enable use of one fuel pump even with an engine including multiple cylinder banks, and facilitates elimination of vapor and air bubbles in the fuel. Further, pump 100 does not include small, or narrow passages that are prone to be clogged by dirt or the like. Pump 100 also is compact. In addition, pump 100 can pump a significant volume of fuel, e.g., pump 100 may operate at one hundred cycles per second. In addition, leakback of fuel from the outlet fuel line is prevented by valve 126, which closes after fuel has been forced from outlet passage 152.

[0038] Figure 4 is aside view of pump housing 102. As shown in Figure 4, housing 102 includes an intermediate section 168 for housing valve 158. Section 168 is in flow communication with first and second pumping chambers 132 and 138.

[0039] Figure 5 is a top view of pump housing 102. A passage 170 is in flow communication with pumping chamber 138 and outlet 106. Figure 6 is a bottom view of pump housing 102. As shown in Figure 6, a passage 172 is in flow communication with pumping chamber 132 and inlet 104.

[0040] Figure 7 is an end view of a first end of pump housing 102. A first notch 174 in housing 102 is provided to accommodate nozzle 118. Figure 8 is an end view of a second end of pump housing 102, and as shown in Figure 8, a second notch 176 is provided to accommodate nozzle 116.

[0041] Figure 9 is aside view of pump inlet cover 114, and Figure 10 is a top view of cover 114. Cover 114 is identical to cover 112, and therefore, the following description with respect to cover 114 also describes cover 112. One advantage of having covers 112 and 114 identical is to ease assembly of pump 100. As explained above, cover 112 includes a nozzle 118.

[0042] Figure 11 is a bottom view of pump inlet cover 114. Figures 12 and 13 are views of opposing ends of cover 114. As shown in Figure 11, an air passage 178 extends from nozzle 118 so that air can flow through nozzle 118 against diaphragm 134. In addition, a seat 144 is provided for spring 136.

[0043] Figure 14 is a side view, and Figures 15 and 16 are views of opposing end, of nozzle 108. Nozzle 108 is identical to nozzle 110, and therefore, the following description with respect to nozzle 108 also describes nozzle 110. One advantage of having nozzles 108 and 110 identical is to ease assembly of pump 100. Nozzle 108 is configured to be coupled to a fuel line, and to house a check valve as described above. In addition, nozzle 108 includes a groove 180 for receiving an oring to form a seal with housing 102. Nozzle 108 may, for example, be sonically welded to housing 102 during assembly of pump 100.

[0044] Figure 17 is a top view of a pump 200 in accordance with a second embodiment of the present invention. Pump 200 includes a housing 202 which forms first and second pumping chambers 204 and 206. Housing 202 also includes inlet nozzles 208 and 210.

[0045] As best shown in Figure 18, which is a cross sectional view of pump 200 along line 18 - 18 in Figure 17, pump 200 includes a diaphragm 212 which extends through first and second pumping chambers 204 and 206. First and second check valves 214 and 216 are located in respective first and second chambers 204 and 206. Pump also including a fuel inlet 218 and a fuel outlet 220.

[0046] Housing 202 includes a main housing section 222, and first and second housing sections 224 and 226 which are sonically welded to section 222. Diaphragm 212 extends between first housing section 224 and main housing section 222, and a seal 228 extends between second housing section 226 and main housing section 222.

[0047] Prior to operation, air lines are coupled to nozzles 208 and 210. As with pump 100, and typically, the air lines extend from engine cylinders that operate 180 degrees out-of-phase

so that alternating pressure and vacuum forces are applied to different sections of diaphragm 212. Rather than cylinders operating 180 degrees out-of-phase, it is possible to select cylinders having a different out-of-phase relationship, e.g., 120 degrees out-of-phase. In addition, a fuel line from a fuel tank is coupled to nozzle 218, and a fuel line to the cylinders is coupled to nozzle 220.

[0048] In operation, when a positive pulse is present at nozzle 208 and a negative pulse is present at nozzle 210, fuel passes through valve from first pumping chamber 204 to second pumping chamber 208. When the pulses are reversed, then a negative pulse is present at nozzle 208 and a positive pulse is present at nozzle 210. As a result, fuel is forced through outlet 220 and drawn into inlet 218.

[0049] From the preceding description of various embodiments of the present invention, it is evident that the objects of the invention are attained. Although the invention has been described and illustrated in detail, it is to be clearly understood that the same is intended by way of illustration and example only and is not to be taken by way of limitation. Accordingly, the spirit and scope of the invention are to be limited only by the terms of the appended claims.